Review #1

PROPOSAL NO.: 0344288
INSTITUTION: University of New Mexico
NSF PROGRAM: SYST BIOLOGY & BIODIV INV CLUS
PRINCIPAL INVESTIGATOR: Larkin, Leah L
TITLE: REVSYS: A Holistic Approach to a Holarctic Group: Subgeneric Relationships Within the Genus Andrena Fabricius (Hymenoptera: Andrenidae) with a Revision of the Subgenus Callandrena
RATING: Very Good

REVIEW:
What is the intellectual merit of the proposed activity?

The genus Andrena is a group of particular interest in the context of insect systematics because, although it includes a very large number of species, these are not very diverse, and subgeneric divisions are very unclear. This poses special intellectual challenges related to obtaining and analysing suitable information for the derivation of phylogenies, and handling and communicating large amounts of data effectively. The proposed project is extremely significant in advancing knowledge and understanding of this important genus of bees. Successful application of the proposed methods will be of significance for the systematic and biodiversity enterprise, worldwide, in so far as it will demonstrate the feasibility of intellectual analysis of such intractable problems. The PI has shown that she is one of the best qualified individuals available to undertake such a project, as is demonstrated by the commitments to collaboration and support which have been obtained from several countries. She has not yet had the opportunity to demonstrate her expertise through extensive publication, but the motivation shows an excellent grasp of the principles involved and the detailed investigations and analyses required. There is full and appropriate (although sometimes possibly excessive) incorporation of the most recent advances in technology and computational approaches. The detail presented in budgeting and planning is reassuring. Provided that the project is sufficiently well funded, there will certainly be sufficient access to the necessary resources; the need for new equipment is minimal. The project well incorporates the aims of the REVSYS program, although it would have been good to see the explicit inclusion of one or more postgraduate students (but the omission may be a result of local circimstances).

What are the broader impacts of the proposed activity?

The proposed project is broad-based, involving the collaboration of several workers across different continents and also providing opportunities for teaching, training and learning of undergraduate students, particularly those from minority communities in the USA. It is thus an admirable project in meeting broad aims, particularly in so far as it will provide opportunities for some people who have not had access to such facilities and training before. By its very nature, the project is designed to promote the dissemination of its results as widely as possible, using electronic technology and the internet, thus empowering people everywhere to utilize them. For society at large, the benefits will be the development and refinement of methods and techniques which will facilitate and encourage our understanding of biodiversity and its importance for human survival.

Summary Statement

This is certainly a timely and significant proposal of high quality which deserves support.

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Review #2

PROPOSAL NO.: 0344288
INSTITUTION: University of New Mexico
NSF PROGRAM: SYST BIOLOGY & BIODIV INV CLUS
PRINCIPAL INVESTIGATOR: Larkin, Leah L
TITLE: REVSYS: A Holistic Approach to a Holarctic Group: Subgeneric Relationships Within the Genus Andrena Fabricius (Hymenoptera: Andrenidae) with a Revision of the Subgenus Callandrena
RATING: Excellent

REVIEW:
If Ms. Larkin is intent upon working on bee phylogeny using maximum likelihood methods of phylogenetic reconstruction, the subgenus Callandrena (genus Andrena) is a very good starting point. It is a large group of bees with over 100 species and has been reasonably well studied in recent years. She has written a reasonably good proposal and I have the notion that it is worth funding at this time. My only concern, and I hope that this can be avoided, is that she does not include even a few of the related, smaller subgenera. Such comparisons should be made before one can conclude that the subgenus Callandrena needs to be split into smaller groups. It appears that she already is contemplating breaking the subgenus Callandrena into smaller units before comparisons with other, and perhaps related, subgenera. This would be premature. Other than that, I have no comments against the proposal and, all and all, I am in favor of supporting this work.

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Review #3

PROPOSAL NO.: 0344288
INSTITUTION: University of New Mexico
NSF PROGRAM: SYST BIOLOGY & BIODIV INV CLUS
PRINCIPAL INVESTIGATOR: Larkin, Leah L
TITLE: REVSYS: A Holistic Approach to a Holarctic Group: Subgeneric Relationships Within the Genus Andrena Fabricius (Hymenoptera: Andrenidae) with a Revision of the Subgenus Callandrena
RATING: Very Good

REVIEW:
What is the intellectual merit of the proposed activity?

The P.I. is well qualified and has produced impressive preliminary results. The proposed research is well planned, though it is not clear that there will be sufficient sampling of all geographic areas. Value added elements include pollen host-plant preferences, parasitoid relationships from a Phylogenetic perspective, and historical biogeography. The P.I. has put together a highly qualified team of bee systematists.

What are the broader impacts of the proposed activity?

Interactive keys to the species of Callandrena and the subgenera of Andrena will be disseminated on the web. Forty new species of Callandrena will be described. Undergraduates are well integrated into the proposed research. The proposals for molecular studies, and biogeographic and phylogenetic analysis appear thorough and demonstrate knowledge of current methods. There is no mention of databasing other than for species locality data. This should certainly be expanded since so much information will be in hand and/or gathered from the literature (type depositions, synonomies, literature, perhaps images of type specimens, etc.).

Summary Statement

OBJECTIVES
The P.I. of this proposal will:
1. Coordinate an international team of Andrena specialists to work collaboratively to meet the goals of the project;
2. Generate a phylogenetic hypothesis, based on DNA sequence data from both mitochondrial and nuclear markers and in collaboration with international colleagues, of a representative sampling of the global diversity of Andrena species (presently with 1400 species described);
3. Identify, using the molecular phylogeny and in collaboration with international colleagues, morphological characters on which to base a natural classification of Andrena and recircumscribe the subgenera to reflect natural, monophyletic groupings;
4. Revise the Nearctic subgenus Callandrena s. str., including the description of the 40 or more new species known from Mesoamerica and the removal from the subgenus the distantly related species formerly ascribed to Callandrena;
5. Produce an interactive key to the species of subgenus Callandrena, and, as time permits, to other Nearctic species;
6. Supervise undergraduate students as full participants in the project.

The genus Andrena presently contains about 1400 species and has been divided into approximately 95,

often artificial, subgenera. The proposed research includes molecular studies to elucidate the phylogeny and monophyly of the subgenera and to revise the species of subgenus Callandrena. Although there are 40 new species of Callandrena s.str. perdicted it is not clear how many undescribed species will be included making the magnitude of the task difficult to judge.

Andrena is primarily found in the Holoarctic region but they are scattered in the Neotropics, Africa, and southeast Asia. The PI has assembled collaborators to supply specimens from the UK and continental Europe, and a Japanese collaborator will be supplying specimens from Japan and Asia. The PI as well as collaborators Ayala, Neff and Ascher will supply Nearctic, including Mexican, samples. 213 species of 45 subgenera, are currently in hand for molecular studies and many have been sequenced with preliminary results presented. This is said to represent 40% of what is needed to accurately sample the subgenera and test monophyly. The remaining 60% of the species needed are presumably the most difficult to get and it is surprising that no expeditions are mentioned. It is not clear that all of these specimens are in-hand. The tropical elements are not included in the sampling effort because they are thought to be recent migrants but it would be nice to see this verified. It would also add a nice biogeographic element.
The interactive key to the species of Callandrena is laudable and it is a major task, modifying the dichotomous key of subgenera into an interactive key will be even more important and it will greatly facilitate the identification of Andrena species world-wide. There is no mention of the software to be used to produce the interactive keys.

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Review #4

PROPOSAL NO.: 0344288
INSTITUTION: University of New Mexico
NSF PROGRAM: SYST BIOLOGY & BIODIV INV CLUS
PRINCIPAL INVESTIGATOR: Larkin, Leah L
TITLE: REVSYS: A Holistic Approach to a Holarctic Group: Subgeneric Relationships Within the Genus Andrena Fabricius (Hymenoptera: Andrenidae) with a Revision of the Subgenus Callandrena
RATING: Excellent

REVIEW:
What is the intellectual merit of the proposed activity?

This is a proposal to make a major study of phylogeny and higher (subgeneric) classification of the genus Andrena, perhaps the largest genus of bees and indeed the largest genus of pollinating insects. With about 95 recognized subgenera and little understanding of the relationships among them, the current situation is rather absurd; some of the subgenera are not natural groups. In addition it is a proposal to complete a species-level revision of the largest subgenus, Callandrena. Species of Andrena are monotonously similar in morphology and according to the PI's earlier molecular work, distantly related species may converge morphologically in various characters. The PI is well qualified for both morphological and molecular studies, as well as for the various statistical methods of analysis of data.

The PI is a capable, ambitious young woman; she clearly needs funding to accomplish her objectives. She has hardly had time to show her qualifications through published works although with the little already published and the papers in press or submitted, she is making a good start. It may seem presumptious that the funds requested are mostly for her salary, considering that she is just beginning her career. I believe that she would be a "good bet," however. If her salary money must be cut, I suggest that the other funding be granted.

The study is of such a size that she cannot finish it in three years without help from her collaborators. I would encourage her to request funds for them to facilitate their work and to get them for visits to New Mexico to collaborate fully, either all at the same time or at different times. Neither their letters nor the body of the proposal indicate clearly what they will do and when.

What are the broader impacts of the proposed activity?

Andrena is full of species that are presumably important, and in some cases essential, for the pollination of natural vegetation and sometimes crops. Predictions, based on systematic relationships, can indicate what taxa of pollinators are likely to be important for various plant populations.

Interactive electronic identification keys will make it possible for the first time for nonspecialists to identify groups and species of this genus.

Undergraduate participation in the research will give students good experience on how research is done and should draw students into systematic biology.

Summary Statement

An excellent proposal, especially considering that the PI is only now beginning her scientific carer. Some possible adjustments are indicated above.

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Review #5

PROPOSAL NO.: 0344288
INSTITUTION: University of New Mexico
NSF PROGRAM: SYST BIOLOGY & BIODIV INV CLUS
PRINCIPAL INVESTIGATOR: Larkin, Leah L
TITLE: REVSYS: A Holistic Approach to a Holarctic Group: Subgeneric Relationships Within the Genus Andrena Fabricius (Hymenoptera: Andrenidae) with a Revision of the Subgenus Callandrena
RATING: Excellent

REVIEW:
What is the intellectual merit of the proposed activity?

The essentially Holarctic bee genus Andrena is a difficult taxonomic group for a number of reasons. It is immense, perhaps the single largest genus of bees with over 1400 species. The species tend to be monotonous morphologically, lacking easily recognizable distinguishing characters. At least 95 subgenera have been proposed, but many of these are poorly defined and have been formulated on the basis of geographically limited studies. The genus has never been completely revised on a worldwide basis.
The PI proposes two main goals. (1) She, in cooperation with her collaborators, plans to prepare a worldwide classification scheme predictive of evolutionary relationships based on a revised suite of morphological characters, these characters to be identified based on a phylogeny derived from DNA sequencing. (2) She plans to revise the Nearctic subgenus Callandrena s.str. including the description and naming of 40 species already recognized as new and removing those species that make Callandrena s.lato polyphyletic according to her Ph.D. thesis studies. Of these two objectives, I rate the first to be more important intellectually because, if successfully undertaken, it will be the touchstone to understanding the phylogeny of this massive genus at long last. This is not to say that her second objective is not worthy, for Callandrena is a large subgenus with many new elements and with interesting patterns of host-plant specificities. Her plan to provide both a dichotomous key and an interactive key in electronic form on the internet for included species speaks further to the intellectual merit of the proposal. Having an understandy of the phylogeny of the genus will make possible investigations on the evolution of floral specialization within various clades. This information may be important to mankind, shedding light on the floral specialization in bees that are of importance to mankind because of their pollinating services in ecosystems and in agriculture.
The PI"s publication record lists five entries, only one of which is authored solely. Although this is not particularly impressive, the PI received her Ph.D. only in 2002. Further, Figure 1 of the proposal as well as table 1 demonstrate intimate experience in understanding and using DNA data in developing and analyzing phylogenetic relationships in Andrena. Also she has put together a team of international collaborators, some of whom are energetic leading andrenid specialist and others of whom can provide expert advice on methodologies. These facts bode will for the successful implementation of the project. Whether it is feasible to develop a DNA based understanding of the phylogeny and, at the same time, revise Callandrena with its 40 new species in a three year period will have to be judged by other reviewers more familiarity with the time required to sequence DNA.

What are the broader impacts of the proposed activity?

The PI"s plan to train undergraduate students in systematics from a Minority-Serving Institution (University of New Mexico) in systematics, have them test the keys, and data base loans and distributional information speaks to the broader merits of the proposal as does her assembling an international groups of scientists as collaborators. (The disjunction between collaborators listed on the

second page of the Biographical Sketch compared with the collaborators identified elsewhere in the proposal and who supplied letters of collaboration was obviously an oversight in compiling the proposal.)

Summary Statement

This is an excellent proposal to develop a phylogenetic understanding of the huge, taxonomically intractable bee genus Andrena. This in turn will lead to a sound classification of the genus worldwide for the first time. Thereafter the various clades can be dealt with both systematically and biologically. The PI has brought together an international team of collaborators to work with her. They are knowledgeable about the genus while some can provide expert advice concerning methodologies.

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Review #6

PROPOSAL NO.: 0344288
INSTITUTION: University of New Mexico
NSF PROGRAM: SYST BIOLOGY & BIODIV INV CLUS
PRINCIPAL INVESTIGATOR: Larkin, Leah L
TITLE: REVSYS: A Holistic Approach to a Holarctic Group: Subgeneric Relationships Within the Genus Andrena Fabricius (Hymenoptera: Andrenidae) with a Revision of the Subgenus Callandrena
RATING: Good

REVIEW:
What is the intellectual merit of the proposed activity?

1. How important is the proposed activity to advancing knowledge and understanding within its own field or across different fields?
Bees are essential for plant pollination in natural and agricultural ecosystems. Andrena is a large genus (ca. 1,400 spp) in need of revision. This proposal seeks to examine ca. 1/3 of the species in Andrena, build a phylogenetic hypothesis based on DNA sequence that will allow for testing the monophyly of subgenera, and derive morphological definitions for subgenera based on the molecular phylogeny. If successfully completed, this work will represent a large contribution to the study of bee systematics.

This proposal will evaluate the usefulness of different genes and different methods for phylogeny reconstruction. It will also seek to use a DNA-based tree to seek morphological characters to define subgenera.

2. How well qualified is the proposer (individual or team) to conduct the project? (If appropriate, please comment on the quality of previous work)
The PI's published molecular work focuses on plants, but a DNA based study of a subgenus of Andrena has been submitted to Molecular Phylogenetics and Evolution. The PI has described five new species of Andrena. The collaborators enlisted seem adequate to perform the work that will be required of them.

3. To what extent is the proposed activity creative and original?
This proposal will make an effort to evaluate the performance of different methods of phylogenetic analyses. This is a commendable aspect of this proposal. Using the DNA-based phylogeny as a base for morphological work is a fine idea, but I have some concerns explained below.

4. How well conceived and organized is the proposed activity?
A large number of samples has already been sequenced, and contacts have been made with collaborators who will provide additional samples.

I am concerned about the ability of the PI to fulfill the goal of deriving morphological definitions for subgenera based on the molecular phylogeny. It is stated in the proposal that subgeneric definitions overlap, but the PI will use published morphological characters that will be scored by undergraduates to build new subgeneric definitions. In the case of groups that are ‘morphologically challenging' (e.g., homogeneous), undergraduates will not have the necessary experience to perform this work. Moreover, in their published work different authors often place emphasis in different characters, or may disagree on characters states definitions. Will this be an issue? If so, how will this issue be settled? The PI might be underestimating the complexity of the morphological work.

5. Is there sufficient access to the necessary resources?

Yes.

What are the broader impacts of the proposed activity?

1. How well does the activity advance discovery and understanding while promoting teaching, training and learning?
Undergraduate students will be involved in sequencing and morphological work. It is unclear how the undergraduates will be trained to perform the morphological work.

It would be good to have graduate students involved in this project. It would also be good to have clarification on the relationship between the UNM and the Museum of Southwestern Biology, where some of the species-level revisions will be performed.

2. How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, geographic, etc)?
Mexican Americans constitute the major ethnic group at the University of New Mexico.

3. To what extent will it enhance the infrastructure for research and education, such as facilities, instrumentation, networks, and partnerships?
The proposed work will mostly promote interactions among faculty at the UNM. Although collaborators from Europe and Asia will provide samples, I found no indication that the PI or collaborators would visit each other while the project is being performed.

4. Will the results be disseminated broadly to enhance scientific and technological understanding?
Dissemination will be via publications and interactive keys to be placed on the web.

5. What may be the benefits of the proposed activity to society?
If successfully accomplished, this project will increase collections and provide interactive keys to the identification of Andrena bees for two regions of the world. Question: will the keys include *all* species of Andrena for each of the focal regions? This will determine how useful the key is, and how well it will work as an identification tool.

Summary Statement

Ths proposal contains good ideas but some points need to be addressed before it can be recommended for funding.

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Review #7

PROPOSAL NO.: 0344288
INSTITUTION: University of New Mexico
NSF PROGRAM: SYST BIOLOGY & BIODIV INV CLUS
PRINCIPAL INVESTIGATOR: Larkin, Leah L
TITLE: REVSYS: A Holistic Approach to a Holarctic Group: Subgeneric Relationships Within the Genus Andrena Fabricius (Hymenoptera: Andrenidae) with a Revision of the Subgenus Callandrena
RATING: Fair

REVIEW:
What is the intellectual merit of the proposed activity?

The PI studies bees and she says that the project will result in "a molecular phylogeny, based on DNA sequences, for...Andrea." And that "...guided by the molecular phylogeny, the PI and collaboratos will revise the subgenera..." and finally the PI will "...focus on the subgenus Callandrena..." for which she will produce a taxonomic treatment. Bees are an important and interesting problem, the proposer is well qualified to do the project. She has arranged to have material sent from outside the USA and will do some collecting inside the USA. I think this sounds like a fine research project, one that involves international collaboration and tackles a difficult systematic problem. In fact it sounds just like proposals that I review for the systematics panel. It is a molecular phylogeny followed by the search for morphological characters and the revision of a part of the group. It is exactly what we do in systematics, and the collecting done in this proposal is targeted just to this genus and is not broad based enough to be either a survey or an inventory.

What are the broader impacts of the proposed activity?

Bees are an important group in pollination and information about their phylogeny would be useful for those studying plants that the bees visit.

The study involves student training

Summary Statement

This project is a basic molecular phylogeny and revision and involves only targeted collecting. I cannot support its funding as either a survey or an inventory.

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